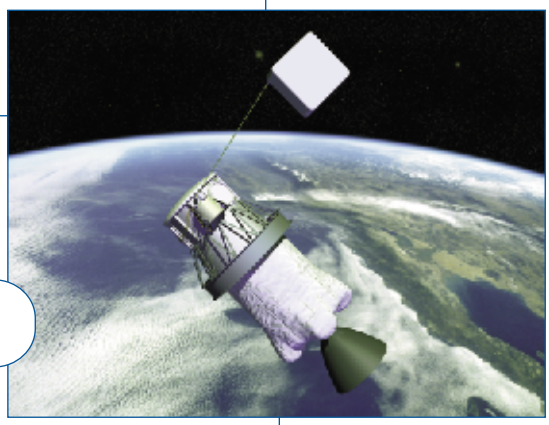
Advanced Space Transportation Technology Summary



Tether Propulsion

The first demonstration of a propellant-free space propulsion system is planned in December 2000. The experiment, developed by NASA's Marshall Space Flight Center in Huntsville, Ala., will use an electrodynamic tether to lower the orbit of a spent rocket stage. It's the first time a tether will be used for propulsion and could lead to a new, reusable system for transportation in space.

Tether propulsion is inexpensive, environmentally clean, completely reusable, and perhaps, best of all, requires no fuel. Its energy comes from the near-Earth space environment. The Propulsive Small Expendable Deployer System experiment—called ProSEDS—uses the familiar concept of like poles of two magnets pushing against each other. When a wire—in this case, the metallic part of a 9.3-mile tether—moves through a magnetic field in the presence of a low-density plasma, as is the case in low-Earth orbit, an electric current is induced in it. The magnetic field created as electric current flows through the tether will push against the much stronger magnetic field that encircles the Earth, lowering the orbital altitude of an object connected to the tether.

Tethers used in previous space missions have been insulated, but ProSEDS will use a radically different and potentially more efficient design for collecting current. The bare, metallic tether, about as thin as dental floss, will collect electrons directly. The bare-wire portion of the tether is 3.1 miles long and spliced to a 6.2-mile nonconducting tether made of Spectra and Kevlar, high-strength fiber materials.

ProSEDS is one of the Future-X flight experiments selected by NASA in December 1998 to help mold the future of space transportation. The first test deployment of a developmental electrodynamic tether was successfully completed in October 1999 at Marshall. Assembly of the experiment hardware begins at Marshall in early 2000. The experiment hardware is scheduled to be shipped to Florida in July, where it will be readied for launch.

ProSEDS will be launched from Cape Canaveral Air Station, Fla., on a Delta II rocket. The Small Expendable Deployer System will deploy the tether from the Delta II second stage and lower its orbit three to six miles per day for several days. The tether should be visible from Earth.

While ProSEDS will demonstrate the use of tethers for deorbiting spacecraft, future experiments are planned to demonstrate the use of tethers for raising the orbit of spacecraft. Tether propulsion applications range from cleaning up space debris that's accumulated over 40 years of space exploration to helping the International Space Station maintain its operating orbit.

NASA's industry team for the ProSEDS experiment includes: Tether Applications of Chula Vista, Calif.; Tethers Unlimited of Seattle; Electric Propulsion Laboratory of Monument, Colo.; Triton Systems Inc. of Chelmsford, Mass.; Smithsonian Astrophysical Observatory of Cambridge, Mass.; Alpha Technologies of Huntsville; Colorado State University in Fort Collins; and the University of Michigan in Ann Arbor.

Tether propulsion is one of many innovative technologies the Marshall Center's Advanced Space Transportation Program is developing to reduce space transportation costs from $10,000 per pound to only hundreds of dollars per pound.